

The background of the cover is a photograph of a coastal cliff. The cliff face is composed of light-colored, horizontally layered sedimentary rock. There are some patches of green vegetation on the top edge of the cliff. At the base of the cliff is a beach covered with numerous smooth, rounded, light-colored rocks and pebbles. The sky is visible at the top of the cliff, appearing overcast.

# **Draft Guidelines for Geotechnical Reports**

**City of San Diego  
2008**

**The City of San Diego**  
**Guidelines for Geotechnical Reports**

**2008**

*Prepared by:*

**Development Services Department  
Division of Building & Safety  
1222 First Avenue  
San Diego, California 92101**

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# 1. INTRODUCTION

## 1.1 Purpose

These guidelines are intended to facilitate the preparation and review of preliminary geotechnical reports and as-graded (as-built) reports submitted to the city of San Diego. The following sections provide information for preparing well-documented reports. Not all of the informational items will be applicable to every site or every project, but the investigative scope should be consistent with the sensitivity of the intended use and the physical constraints of the site. It is not the intent of these guidelines to specify methods or scope of studies for individual projects or to supplant the judgment of the licensed geotechnical<sup>1</sup> consultant. No provision in these guidelines is mandatory or should be construed to constitute a statute, ordinance, or regulation, unless stipulated elsewhere.

Geologic conditions exist within the City of San Diego that can pose serious problems when land is developed. No permits shall be issued where the geotechnical investigation establishes that land development or construction of structures would be unsafe due to geologic hazards. Issuance of a permit does not constitute a representation that the site or construction is safe.

## 1.2 The Permit Process

The various permits required for land development and construction are issued by the Development Services Department (1222 First Avenue). These permits fall into two general categories: development permits and construction permits<sup>2</sup>. Development permits or entitlements are discretionary in nature, granted at the discretion of a decision maker. Depending on the type of project, the decision maker could be City staff, a Hearing Officer, the Planning Commission, or the City Council. Examples of development permits include Coastal Development Permits, Site Development Permits, Neighborhood Development Permits, Conditional Use Permits, lot splits, condominium conversions, and Tentative Maps. Construction permits are ministerial, which means that projects found to comply City standards and existing property entitlements can be permitted without a public hearing. Grading plans, improvement plans, and building plans are examples of ministerial permits.

- **Project Tracking System (PTS):** The Development Services Department uses an electronic tracking and permitting system developed in-house called the Project Tracking System (PTS). This system is utilized from first contact to final inspection and approval. It provides a detailed record of the project history for all reviewing disciplines (discretionary and ministerial). All permit applications are assigned a project tracking system number, or PTS number, and tracked in the Development Services data base.
- 1) **Discretionary Permits:** At the beginning of the discretionary review process, the City assigns the project to a single point of contact called a Development Project Manager (DPM). This person coordinates each discipline's involvement in the discretionary review. Typically discretionary projects have one PTS number and the submittal packages are tracked in multiple-discipline review cycles. If necessary, resubmittal packages for each discipline are processed concurrently in a single review cycle managed by the DPM. An assessment letter that provides a summary of progress and required action is sent directly to the applicant or point of contact by the DPM.
- 2) **Ministerial Permits:** For ministerial projects, intake staff route the submitted plans and supporting documents to selected review disciplines. Each discipline (i.e. Geology) manages their assigned reviews independently and may or may not coordinate with other disciplines, depending on project requirements.

Ministerial projects may have one or many PTS numbers, each associated with an individual permit. Each review discipline is assigned an individual review cycle and submittal packages are tracked as an individual review cycle for each discipline. Resubmittal packages for each discipline are assigned to new review cycles.

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<sup>1</sup> For the purposes of this document, "geotechnical" encompasses both the fields of geotechnical (soils) engineering and engineering geology.

<sup>2</sup> (for additional information see the Development Process: Step by Step at:  
<http://www.sandiego.gov/development-services/devprocess/discreview/index.shtml>).

Each discipline provides a “Cycle Issues” report or “Remaining Cycle Issues” report that is sent to the point of contact by their choice of fax or email and/or via plan pick-up located on the 3<sup>rd</sup> floor of the Development Services Center.

If a submittal package provides the necessary information, the disciplines will sign-off in PTS. When all disciplines have cleared their review comments, closed their review, and signed-off, the plans can be approved.

- **Submittal:** Plans and documents submitted for proposed projects are referred to as a “submittal package.” Geotechnical reports provided in the original “submittal package” or as part of a subsequent resubmittal will be assigned to a reviewer for processing. Due dates are set by department standards based upon project size and complexity. Typically, several cycles are required to complete the geologic review.

Submittals are made on the 3rd floor of the Development Services Center located at 1222 First Avenue in downtown San Diego. Appointments are recommended and can be made by phoning (619) 446-5300. Please refer to the Project Submittal Manual for specific submittal requirements.<sup>3</sup>

For the Geology Section, resubmittal packages can be submitted at intake on 3rd floor of the Development Services Center or over the counter by appointment on the 4th floor of the Development Services Center directly to the reviewer. Please check with the reviewer for availability. Always include the PTS Number on every document in the resubmittal package.

- **Geotechnical Review:** Geologic and geotechnical reports submitted to the City are reviewed by the Geology Section of Development Services for conformity with City and State standards. These guidelines are the basis for interpreting minimum City standards. When warranted, reviewers include a field reconnaissance of the project site.

In some cases, such as when geologic conditions could restrict the intended use of the site, a developer may choose to have city staff review preliminary plans and reports prior to completing final design or making a formal submittal. This process is called “Preliminary Review”(see Information Bulletin 513) and should be used whenever geologic hazards are encountered during the investigative stage that could negatively impact the planned project. Preliminary Review can also be used whenever there are questions of Development Services staff needing to be answered prior to your submittal.

### 1.3 Definitions

- **Applicant:** Project applicants include developers, landowners, and others directly involved with development or construction activities. Applicants are responsible for submittal of complete documents and payment of fees.
- **Building Official:** Manager of Building and Safety, which is the division that issues construction permits based, in part, upon adequate project plans and technical documents. The Building Official resolves issues or conflicts regarding construction practices or code interpretations.
- **City Engineer:** A registered civil engineer responsible for oversight and approval of City works. The City Engineer, or designees (Deputy City Engineer), is responsible for approving grading permits, right-of-way permits (e.g. improvement plans), and maps.
- **Development Services:** The City Department that regulates private development and construction. Development Services has two divisions: Land Development and Building and Safety. Land Development regulates discretionary permits and Building and Safety regulates ministerial (construction) permits. The Geology Section reviews all geotechnical reports for the department.
- **Development Project Manager (DPM):** A single point of contact for the applicant during the discretionary permitting process. The DPM is responsible for determining the project approval path and timeline, estimating processing costs and managing turn around times for project reviews. A DPM is also assigned to ministerial projects; however, this DPM does not generally manage these projects.

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<sup>3</sup> (<http://www.sandiego.gov/development-services/industry/codes.shtml#submanual>).

- **Engineering and Capital Projects:** The City Department responsible for planning, design and construction of public improvement projects that encompass building fire stations, bridges, libraries, police stations, bikeways, drainage, street lights, traffic signals, street improvements, underground facilities, and water and sewer facilities.
- **Engineer of Work:** The consulting engineer who designs and is responsible for the proposed project plans.
- **Environmental Analyst:** The City staff member who conducts environmental review and writes the environmental document during the discretionary permitting process in accordance with the California Environmental Quality Act (CEQA) of 1970.
- **Geotechnical Consultants:** Appropriately registered and licensed professionals that provide geologic and geotechnical engineering services for project applicants. These consultants provide design recommendations, approve project plans and specifications, and provide construction observation services. Geotechnical consultants include:
  - **Soil Engineer:** A State of California licensed Professional Engineer (PE) who practices soil engineering.
  - **Registered Civil Engineer:** A State of California licensed Professional Engineer (PE).
  - **Geotechnical Engineer:** A PE who is additionally a State of California Registered Geotechnical Engineer (GE)
  - **Professional Geologist:** A State of California licensed Professional Geologist (PG).
  - **Engineering Geologist:** A PG who is also State of California Certified Engineering Geologist (CEG).
- **Geotechnical Reports:** This is an inclusive term covering many types of geologic and geotechnical engineering documents. Documents referred to as preliminary soil reports, geologic reconnaissance reports, geologic investigation reports, fault hazard studies, geotechnical investigation reports, preliminary geotechnical reports, and as-graded geotechnical reports, are examples of geotechnical reports.
- **Reviewer:** Appropriately licensed professional City staff member (or employees working directly under the supervision of appropriately licensed and registered professionals) who reviews geotechnical reports. Appropriately licensed and registered professionals providing services under contract with the City may also review geotechnical reports. Geotechnical reports are evaluated for conformity with City and State codes, ordinances, and standards. These guidelines are the basis for interpreting minimum City standards.

#### 1.4 Applicable Codes, Ordinances, and Guidelines

Geotechnical consultants providing services in the City of San Diego should be familiar with the current codes, ordinances, and guidelines applicable to development and construction including the following:

- San Diego Municipal Code<sup>4</sup>
- San Diego General Plan, Seismic Safety Element
- San Diego Drainage Manual
- California Building Code (CBC), City Amendments
- Subdivision Map Act of 1907, and Amendments
- California Environmental Quality Act of 1970, and Amendments
- Alquist-Priolo Earthquake Fault Zone Act of 1972, and Amendments
- Seismic Hazards Mapping Act of 1990

In addition to applicable codes and ordinances, applicants and consultants should be familiar with the selected references listed in Appendix A.

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<sup>4</sup> <http://clerkdoc.sannet.gov/Website/mc/mc.html>

## **1.5 City Records Research and Publications**

Records and maps of projects previously permitted by the city can be researched on the 2<sup>nd</sup> Floor at the Development Services Department at 1222 First Avenue. Geotechnical reports are available for viewing on microfiche and may be copied. Microfiche is filed by the City Soil File Number (Project Work Order No. or PTS No.) or by Lambert Coordinates. Publications such as the City of San Diego Seismic Safety Study Maps or copies of this document are available at the Records Section as well. It is recommended that an appointment be made in advance by calling 619-446-5200 or 619-446-5300. Duplicates of microfiche can be obtained by contacting the City Clerk's office.

## **1.6 Consumer Information Regarding Geotechnical Reports**

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes. The following information should be considered by the customer:

- Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects
- A Geotechnical Report is Based on a Unique Set of Project-Specific Factors
- Subsurface Conditions Can Change
- Most Geotechnical Findings Are Professional Opinions
- A Report's Recommendations Are Not Final
- A Geotechnical Report is Subject to Misinterpretation
- The Consumer Must Not Edit the Contents of the Geotechnical Report
- A Complete Report is Required by Regulating Agencies, Design Professionals, and Contractors
- Read and Understand Responsibility Provisions
- Geo-environmental Issues Are Typically Not Addressed In Geotechnical Reports
- Rely on Your Geotechnical Consultant for Additional Assistance or Contact ASFE at [www.asfe.org](http://www.asfe.org)

## **2. GEOTECHNICAL REPORTS**

The appropriate scope of a geotechnical report is a function of the type of proposed land use or project, the soil/ geologic conditions of the project site, and type of permit or approval sought. The geotechnical consultant is responsible for targeting the scope of their investigation, testing, analyses, and documentation to balance these factors. Unnecessary delays in obtaining permits or approvals can be avoided by submitting appropriately focused geotechnical reports that address the plans submitted for permitting or approval.

The City recognizes two basic types of geotechnical studies: geotechnical reports and as-built or as-graded geotechnical reports. Geotechnical reports that address a proposed project are considered preliminary reports whether they address development or construction plans. Types of geotechnical reports include soils reports, geologic reconnaissance reports, geologic hazard investigations reports, geotechnical investigation reports, or many other types of focused geotechnical reports addressing a proposed project.

Geotechnical reports that address aspects of the construction of a project are referred to as as-graded or as-built geotechnical reports. These geotechnical reports address geologic conditions encountered during construction or grading and document various aspects of construction observation and testing. As-graded or as-built geotechnical reports include compaction test reports and foundation inspection reports, as well as many other types of geotechnical reports documenting construction inspection and/or testing (see Section 7.0).

Comprehensive geotechnical reports may sufficiently address all the requirements of the various permits that might be required by a project. However, it is often the case that project plans change during the permitting process. The applicant must decide if a comprehensive geotechnical report should be submitted and updated as plans evolve or if permit specific geotechnical reports are appropriate for their project.

## **2.1. Geologic Hazard Category**

The city uses the San Diego Seismic Safety Study, a set of geologic hazard maps and associated tables, as a guideline to determine the relative risk associated with the anticipated geologic conditions at the site. These maps also provide information regarding the level of investigation required for various development projects based upon use and hazard category. The maps are planning tools and should not be considered a source for site-specific geologic information. However, the geotechnical consultant must consider the geologic hazard category when formulating the scope of their investigation. Detailed requirements for geotechnical reports are addressed in Section 6.

## **2.2 Types of Land Uses and Projects**

Geotechnical investigation reports should focus on the specific type of land use or project that is proposed. Proposed projects can be broadly divided in Land Development and Construction projects. Land development projects typically require discretionary approval and often involve public hearings. Construction projects require ministerial permits.

### **2.2.1 Discretionary Projects**

Geotechnical reports for discretionary projects should provide geologic input needed for environmental documents, address the geologic issues for certain sites as required by the San Diego Municipal Code (Section 143.01, Environmentally Sensitive Lands Regulations), and/ or address the suitability of sites proposed for Tentative Subdivision Maps.

For environmental documents, the scope of the geotechnical investigation must be sufficient to identify existing and potential geologic hazards, determine potential impacts, recommend mitigation measures, and/ or identify significant unmitigated geologic impacts. The geotechnical consultant should refer to California Geological Survey Note 46 for a checklist of items that should be addressed.

Every development proposed on a sensitive coastal bluff (within 100 feet of the bluff edge) or on the beach) will be subject to the Environmentally Sensitive Lands regulations.

A geotechnical investigation submitted for the purpose of determining the development feasibility of a Tentative Subdivision Map must provide sufficient geologic information to substantiate that the geologic hazards of the site have been adequately identified and the impacts related to the development have been established. The geotechnical investigation must conclude that the site is suitable for the proposed development as designed or the consultant must provide recommendations to mitigate the geologic hazards to an acceptable level. Hazard zones such as structural setbacks from faults or slopes must be identified and shown on the Tentative Map.

For discretionary projects, the geotechnical consultant should be prepared to defend their findings, conclusions, or recommendations in a public hearing, if necessary.

### **2.2.2 Ministerial Projects**

Geotechnical investigation reports for these projects must specifically address the construction plans submitted for approval and provide detailed construction recommendations and specifications with supporting data.

## **2.3 Exemptions**

Geotechnical investigations are not required to be submitted for minor additions or minor projects in areas with a gradient flatter than 5:1 and low or nominal risk of geologic hazards if environmentally sensitive lands or cultural resources are not an issue. If a preliminary geotechnical report is not submitted, conservative parameters should be assumed for design. See Information Bulletin 515 and San Diego Municipal Code §145.0203 for details.

City review of project plans or field conditions may determine that a geotechnical investigation is required for any project.

## **2.4 Expiration Date**

Geotechnical reports submitted for support of permits should reflect the current site conditions and proposed project. An addendum geotechnical report or updated geotechnical report may be required if site conditions differ or proposed project elements have changed relative to those addressed in the geotechnical report. Geotechnical reports are considered valid for three years unless the geotechnical consultant identifies a shorter expiration date.

## **3. CHANGE OF GEOTECHNICAL CONSULTANT OF RECORD**

A change of geotechnical consultant of record must be processed if the project's geotechnical consultant is changed after a permit has been issued and before the project is as-built. The new geotechnical consultant must prepare a Transfer of Geotechnical Responsibility letter. If the new geotechnical consultant utilized the geotechnical investigation and test data prepared by the previous geotechnical consultants of record, the new geotechnical consultant must reference the geotechnical reports approved for the project and must state that they agree with the data, recommendations and conclusions contained in those reports. The new consultant must also state that the data, recommendations and conclusions are valid for the proposed construction. For grading permits, the specific drawing number must be included in the statement. Alternatively, the new geotechnical consultant must conduct their own independent geotechnical investigation.

A change of geotechnical consultant of record after a grading permit has been issued will require a formal construction change to the grading plans.

## **4. SUBSURFACE EXPLORATION PERMITS**

Permits for exploratory excavations and monitoring wells must be obtained in compliance with OSHA and County of San Diego requirements. Contact the County regarding well/ boring permits and backfill requirements. Information is available on line.

Information on how to obtain a grading permit for exploration on a site that contains environmentally sensitive lands can be found in Information Bulletin 560 (see Appendix B).

Pursuant to State Assembly Bill (AB) 73, every person planning to conduct any subsurface excavation is required to contact a regional notification center at least 2 days prior to excavation and, if practical, delineate the areas to be excavated.

The City of San Diego Trench-Cut Excavation Ordinance (Municipal Code 62.1200), describes the requirements for excavations in the Public Right-of-Way. Consultants should also contact the City Engineer for permission to excavate in the Right-of-Way and for traffic control requirements.

## **5. GEOTECHNICAL REPORT CONTENT**

Outlined herein are the major elements of a geotechnical report. These elements will be present in most geotechnical reports, however all of these elements may not be applicable to every project. The geotechnical consultant will determine the organization and format of the report.

### **5.1 Introductory Information**

#### **5.1.1 Purpose**

The report shall clearly identify the purpose of the geotechnical investigation. Indicate if the investigation is intended to be comprehensive or if it addresses a specific permit (i.e., grading plan).

#### **5.1.2 Site Description**

Describe the site location and access. Provide a description of the physiography (geomorphology), vegetation, and significant cultural (man-made) features of the site. Describe natural and manufactured slope height and gradient (or ratio). Reference to an index map that uses a topographic base may reduce the need for lengthy descriptions.

#### **5.1.3 Proposed Development**

Provide a general description of the proposed project. Reference should be made to the plans addressed by the investigation.

#### **5.1.4 Previous Studies**

List and describe the relevant published and unpublished literature pertinent to the geologic or geotechnical aspects of the site. Typically this will include regional geologic reports and maps as well as reports by other geotechnical consultants. All geotechnical data utilized from previous investigations that are used to support geologic and geotechnical engineering interpretations should be referenced in the report.

If a geotechnical consultant utilizes the geotechnical report and test data prepared by another geotechnical consultant, they must reference the geotechnical reports approved for the project and state that they agree with the data and conclusions contained in those reports. Copies of referenced reports must accompany the submitted report.

#### **5.1.5 Scope of Investigation**

Describe the research, field exploration, laboratory testing, and analyses conducted. Details of the methods and procedures used in the investigation may be described in the introduction, in the body of the report, or in an appendix.

### **5.2 Geologic/Geotechnical Site Conditions**

Describe the geologic and/or geotechnical conditions of the site. The emphasis of this section should reflect the Geologic Hazard Category of the site as depicted on the San Diego Seismic Safety maps.

### **5.3 Geologic/ Geotechnical Analysis**

Describe and discuss site or project specific geologic or geotechnical analyses. For example, a geotechnical report that focuses on slope stability should describe the stability analyses that were conducted and discuss the results.

### **5.4 Surface Stormwater Run-off/Infiltration**

Describe and discuss site or project specific surface and subsurface geology and hydrogeologic conditions of the site in order to develop necessary mitigation measures to allow for infiltration as a means of controlling surface stormwater runoff. For example, a report identifying Street Edge Alternatives (SEA) should describe the subsurface analysis that was conducted and provide an explanation of the results.

### **5.5 Conclusions**

A conclusion regarding the suitability of the site for the intended use should be provided. Summarize all hazardous or damaging geologic or geotechnical conditions potentially impacting the proposed development. Conclusions and opinions should be substantiated by factual information and/or experience. Where a conclusion is based on experience or judgment, the rationale used should be clearly discussed.

### **5.6 Recommendations**

Provide project specific recommendations targeting the type of permit that is sought. For environmental review, provide recommendations to mitigate or avoid geologic hazards. For grading permits, provide grading recommendations. A preliminary geotechnical report addressing building plans should provide foundation and design recommendations. A report may provide comprehensive recommendations for all phases of the permit process. However, updated recommendations may be required as plans evolve.

The geotechnical consultant should indicate if additional exploration, testing, or analyses are recommended to address the proposed project.

### **5.7 Illustrations**

Maps, cross sections, plans, and details are important tools for conveying location, geological, and geotechnical information and recommendations. Illustrations should be clear and all symbols must be defined for the illustrations to be understood. A graphic scale and north arrow should be provided on all maps. Typical illustrations of preliminary geotechnical reports include an index map (site location map), regional geologic map, geological or geotechnical maps, and cross sections.

### **5.8 Logs of Exploratory Excavations (including Cone Penetration Test Data)**

Present logs for all exploratory excavations and a legend for all symbols used in the logs. See Appendix B for additional details.

### **5.9 Geophysical Data**

Attach geophysical data and/or graphical output from geophysical studies used to support the findings, conclusions, and recommendations.

### **5.10 Geotechnical Test Data**

The geotechnical consultant should conduct sufficient in situ and/or laboratory testing to characterize the physical geotechnical parameters of the earth materials affecting the proposed development. The test procedures and sample preparation should be described and the applicable ASTM standard referenced. The resulting test data should be presented in tabular format or plots as deemed appropriate. The presented data should be representative of site conditions and must substantiate the geotechnical parameters used for analyses. See Appendix C for additional discussion.

### **5.11 Computer Aided Analysis - Output**

Attach the relevant output of computer-aided analyses. The user defined geologic or geotechnical input parameters should be clearly documented.

### **5.12 References**

Provide a bibliography that includes cited publications, unpublished reports, aerial photographs, etc.

### **5.13 Authentication**

All geotechnical reports submitted to the City of San Diego must be signed and/ or seal (stamped) by an appropriately licensed professional as prescribed by State Law.

## **6. GUIDELINES FOR GEOTECHNICAL REPORTS**

### **6.1 Geology**

#### **6.1.1 Regional Geological Setting**

Geotechnical reports should provide a discussion with respect to the regional geologic setting of the project site. The level of detail should be consistent with the focus of the investigation and the type of proposed project and type of permit. At a minimum, the Geologic Hazard Category or Categories of the site must be identified, based on the San Diego Seismic Safety Study maps.

#### **6.1.2 Site Geology**

The earth materials at the subject site must be described in all geotechnical reports. The descriptions should be based on independent observation by the licensed professional geotechnical consultant or qualified individuals under their supervision.

Professional Geologists should refer to Guidelines for Engineering Geologic Reports prepared by the State of California Board for Geologist and Geophysicists (1998). A comprehensive geotechnical report focusing on site geology would address the following where applicable:

##### **6.1.2.1 Bedrock Units**

Identify geologic units on or beneath the site and discuss their relative age and correlation to known formations. Describe the physical characteristics and distribution of the units and relationship to other geologic units on site. Also describe the bedrock unit's response to geologic processes and engineering characteristics.

##### **6.1.2.1 Geologic Structure**

Describe the bedding, folds, fractures, joint, faults, etc. of the bedrock units. The description should include the attitude and other quantitative attributes of the structures. Discuss the relationship of the geologic structure to potential impact on the proposed project. Indicate if the geologic structure is favorable or adverse with respect to slope stability, proposed excavations, or grading.

#### **6.1.2.1 Surficial Deposits**

Surficial deposits include artificial fill, topsoil, alluvium, colluvium, beach sands and gravels, landslide debris and other types of earth materials mantling bedrock or occurring on or near the surface. The general type, distribution, occurrence, and relative age of the deposits should be described. In addition, physical characteristics and response to surface processes and engineering characteristics should be described.

#### **6.1.2.1 Surface Water and Groundwater**

The occurrence of streams, ponds, springs, and seeps on the site must be identified and described in relationships to site topography and geology. The sources, variation, and permanence of the surface water and groundwater conditions must be discussed. Any surface water hazards and possible affects on the proposed development shall be addressed.

### **6.2 Geologic/ Geotechnical Hazards**

Geotechnical reports for discretionary permits should address all potential geologic hazards of a site proposed for development with focus on the geologic hazards implied by the geologic hazard category of the site as shown on the San Diego Seismic Safety Study maps. When hazards are identified, potential impacts must be described, feasible mitigation measures discussed, and remaining unmitigated significant affects recognized. Reports for ministerial permits should focus on design-level analyses and remedial recommendations.

#### **6.2.1 Landslides**

The movement of a mass of rock, debris, or earth down a slope is considered a landslide. Preliminary Geotechnical Reports for proposed projects in hillside areas (slopes greater than 5 horizontal to 1 vertical) must address the presence of landslides within or adjacent to the site. In addition, the potential for surficial instability, debris/ mudflow, rock fall, and soil creep impacting the proposed development or being impacted by the proposed project must be addressed. Landslide assessments shall take into account all foreseeable temporary and/or permanent site conditions that could influence slope stability on or in the vicinity of the subject property during and/or following project development. Such site conditions may include, but are not limited to seismic forces, structural loading, site grading, excavation, roadway, haul road, cut, fill, stockpile, groundwater, surface water, and stormwater infiltration conditions.

Deep-seated landslides, if present, may require a detailed investigation involving aerial photograph interpretation, field mapping, subsurface exploration, and geologic analysis to determine the limits, geometry, and mode of failure of the landslide. For bedrock sites, subsurface exploration of landslides typical involves detailed direct observation in drilled shafts (borings) conducted by an engineering geologist.

For proposed hillside or bluff top developments, the geotechnical consultant should address if the geologic conditions are favorable or unfavorable for future slope stability. In addition, the geotechnical consultant should identify slopes that may be susceptible to instability due to earthquakes or stormwater infiltration. New developments on slopes or resulting in slopes with less than a static factor of safety of 1.5 are not permitted.

#### **6.2.2 Earthquake Fault-Rupture Hazard**

All geotechnical reports should address if the proposed project site is located in an Alquist-Priolo Fault-Rupture Hazard Zone<sup>5</sup>.

Most proposed projects located in Alquist-Priolo Earthquake Fault Hazards Zones (Geologic Hazard Category 11), potentially active fault zones (Geologic Hazard Category 12), and the Downtown Special Fault Zone (Geologic Hazard Category 13) will require a fault-rupture hazard evaluation as part of the geotechnical report. For additional details refer to Appendix D – Guidelines for Fault-Rupture Hazard Investigation Reports.

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<sup>5</sup> <http://www.consrv.ca.gov/cgs/rgm/ap/index.htm>

### **6.2.2 Earthquake Ground Shaking**

Describe the regional tectonic setting and characterize the hazard of potential earthquake ground shaking (strong ground motion) at the proposed project site. The consultant should refer to California Geological Survey Special Publication 117 (1997); Recommended Procedures for implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Liquefaction Hazards in California, Southern California Earthquake Center (1999)<sup>6</sup>.

### **6.2.2 Earthquake Induced Ground Failure**

Geotechnical reports for discretionary permits should address the likelihood of earthquake induced ground failure at the proposed project site. For sites located in Geologic Hazard Category 31 and 32, the report should specifically address liquefaction, dry sand settlement, lateral spread, and flow slides.

Screening-level investigations may be appropriate for proposed projects seeking discretionary approval. However, if ground improvement is recommended, a design-level investigation to determine the proposed limits of ground disturbance may be required to determine the collateral impacts to environmentally sensitive lands or historic or prehistoric resources.

Geotechnical reports for ministerial projects located in Geologic Hazard Category 31 should evaluate liquefaction hazards in accordance with section 6.4.2 of these guidelines. Liquefaction hazard assessment shall take into account any increase in groundwater elevation, or groundwater mounding that could occur as a result of stormwater infiltration facilities included as a part of the development.

### **6.2.2 Tsunami, Seiche, and Flooding (Earthquake Induced Dam Failure)**

Seismic sea waves (tsunamis) may be a hazard for sites located in low-lying coastal areas of San Diego. Geotechnical consultants should refer to the Multi-Jurisdictional Hazard Mitigation Plan, San Diego County, CA (2004)<sup>7</sup> for the location of sites at risk. The consultant must address the tsunami hazard for sites located in these areas.

The consultant should also address the potential for flooding due to seiche adjacent enclosed or semi-enclosed bodies of water or the potential for flooding due to earthquake induced dam failure.

## **6.3 Coastal Geology**

Proposed projects located within 100-feet of the coast that are applying for a discretionary permit are subject to the requirements of San Diego Municipal Code (§143.0143) and the Coastal Bluffs and Beaches Guidelines. Geotechnical reports for proposed projects in Geologic Hazard Category 41-48 require a bluff edge determination in accordance with the Coastal Bluffs and Beaches Guidelines (see <http://www.sandiego.gov/development-services/industry/pdf/landdevmanual/ldmcoastal.pdf>).

A geologic map and three cross sections must be presented for each proposed project within 100-feet of the coastal bluff edge. The geologic map and cross section must clearly identify the bluff edge. The cross sections should be aligned orthogonal to the bluff edge and located on each side of the property and one located intermediate between the other two. The geologic map and cross sections should show the distribution of geologic units, depict geologic structure, and represent ground water conditions.

Bluff stability at the site must be addressed. All areas of the site with static a factor-of-safety less than 1.5 for gross and surficial stability should be identified.

Coastal bluff recession rates must be addressed. The recession rate must support an appropriate bluff set back for the anticipated life span (75 years) of proposed structures within 100 feet of the coastal bluff edge. Minimum set backs from the bluff edge are discussed in the San Diego Municipal Code (§143.0143 (f)). Copies of aerial photographs or historic maps used to determine

<sup>6</sup> <http://www.scec.org/resources/catalog/hazardmitigation.html>

<sup>7</sup> <http://www.sdcounty.ca.gov/oes/em/resources/mitigation/HazMit%20Plan.pdf>

coastal bluff recession rates must be provided. Show where distances were measured on the aerial photographs or historic maps.

The geotechnical report must include an analysis of the potential effects on bluff stability of rising sea levels, using the latest scientific data (SDMC 143.0143 (B)) and an analysis of the potential effects of past and projected El Nino events on bluff stability (SDMC 143.0143 (C)). The report must also provide an analysis of whether this section of coastline is under a process of retreat (SDMC 143.0143(D)).

## **6.4 Geotechnical Evaluation**

### **6.4.1 Slope Stability Analyses**

When appropriate, analysis of slope stability should be conducted in accordance with the American Society of Civil Engineering (ASCE) and Southern California Earthquake Center (2002) Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Landslide Hazards in California<sup>8</sup>. A factor of safety of 1.5 for static long-term slope stability and 1.25 for static short-term (during construction) stability are minimum standards.

#### **6.4.1.1 Surficial Slope Stability**

Surficial instability typically occurs on steep slopes during periods of prolonged or intense rain or due to excessive irrigation or waterline breaks. Debris and mudflows are examples of surficial instability. Where natural or proposed slopes are steeper than 2:1 (horizontal to vertical), a surficial stability analysis will be required.

The assessment of surficial slope stability shall be modeled as an infinite slope with seepage parallel to the slope surface. If the depth of saturation used in the analysis is less than 5-feet, the shallower depth must be justified. Shear strengths should be based on saturated samples tested at representative effective overburden pressures.

Surficial stability analyses should be performed under rapid drawdown conditions where applicable (e.g., for debris and detention basins).

#### **6.4.1.2 Static Gross Stability**

Geotechnical reports are typically required to evaluate gross slope stability for proposed projects located in Geologic Hazard Categories 21-27 and 41-46. An evaluation of gross slope stability may be required in other Geologic Hazard Categories if non-conforming slopes or adverse geologic conditions are indicated.

Gross stability analyses should be based on accurately modeled geologic conditions and appropriate geotechnical test data. The analysis will typically evaluate either rotational or translational stability as appropriate to reflect geologic conditions. The use of isotropic or anisotropic strength parameters in the analysis along with the soil or geologic conditions should be discussed. Modeling of the groundwater conditions, including any influence from existing and/or proposed infiltration facilities, should be described and included in the slope stability model to be analyzed.

Subsurface exploration should be sufficiently deep to assess the conditions at or below the level of the deepest potential failure path with an inadequate factor of safety. For stability analysis of slopes involving geologic units, subsurface exploration typically relies on detailed direct observation and sampling in drilled shafts (borings) conducted by an engineering geologist. Where direct observation is not possible, the geotechnical consultant should apply appropriately conservative shear strength parameters and assume worst-case geologic conditions.

A geologic cross section should be presented for each natural slope or cut slope analyzed for slope stability. The analyzed cross section should extend beyond the top and toe of the slope being evaluated. Each geologic cross section must be representative of the subsurface geologic and groundwater conditions of the site and/or adjacent areas. If on-site sewage or storm water disposal exists or is proposed, the slope stability analyses should include the effects of the effluent plume on slope stability.

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<sup>8</sup> (<http://www.scec.org/resources/catalog/hazardmitigation.html>)

Each stability analysis presented in a preliminary geotechnical report should be described and the results discussed. The description should include the method of analysis, specified material profile, pore pressures, and specified search areas for critical failure paths. Where multiple slope stability analyses are conducted, a tabulated summary of the analyses and results should be provided.

#### **6.4.1.3 Seismic Slope Stability Analysis**

Slopes prone to earthquake induced instability should be analyzed in accordance with the American Society of Civil Engineering (ASCE) and Southern California Earthquake Center (2002) Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Landslide Hazards in California<sup>9</sup> or an equivalent method.

### **6.4.2 Seismic Induced Ground Failure**

The geotechnical consultant must quantify expected total and differential seismic induced settlement. The geotechnical consultant must conduct sufficient subsurface exploration, sampling, and analyses to support an explicit conclusion that any proposed structure for human occupancy will not collapse due to ground failure during an earthquake if their recommendations are followed.

Investigation of soil liquefaction, dry sand settlement, lateral spread and flow slide should be conducted per California Geological Survey (1997), Special Publication 117; Southern California Earthquake Center (1999) Recommended Procedures for implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Liquefaction Hazards in California; Lew, M. (2001) Liquefaction Evaluation Guidelines for Practicing Engineering and Geologic Professionals and Regulators, Environmental & Engineering Geoscience, Vol. VII, No. 4 or an equivalent method.

#### **6.4.3 Hydroconsolidation**

Some soils under constant load may undergo a decrease in volume when wetted, which is referred to as hydroconsolidation or hydrocollapse. Materials prone to hydroconsolidation include artificial fill, and rapidly deposited alluvium and mudflow debris. The composition of materials most susceptible to hydroconsolidation potential include silty to clayey sands that exhibit a degree of cementation.

Based on ASTM D5333, the potential severity of hydroconsolidation at a pressure of four ksf, ranges from none (0%), slight (0.1 to 2.0%), moderate (2.1 to 6.0%), moderately severe (6.1 to 10.0%), to severe (>10%).

When appropriate, the Geotechnical Consultant shall identify and evaluate the potential affects of Hydroconsolidation. The evaluation shall consider the potential impacts of all aspects of the proposed development, including proposed stormwater management facilities, on both existing and future structures and conditions at the site in question and nearby properties. When appropriate, the Geotechnical Consultant shall provide recommendations for remediation of Hydroconsolidation prone soils based on site specific considerations and accepted engineering practices.

#### **6.4.4 Expansive Soils**

Soils with an expansion index of more than 20 are considered expansive and are subject to changes in volume with changes in the moisture content. An increase in moisture can cause swelling resulting in foundation and slab uplift, while decreasing moisture can result in settlement. Recommendations must be provided to mitigate expansive soil conditions.

Geotechnical site evaluations shall identify potentially expansive soils and the extent of such soils when appropriate. The Geotechnical Consultant shall identify any potential impact the expansive soils may have on proposed structures at the site, as well as how proposed site improvements, including any infiltration measures, may affect nearby properties with respect to expansive soils.

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<sup>9</sup> <http://www.scec.org/resources/catalog/hazardmitigation.html>

#### **6.4.5 Settlement**

The geotechnical consultant shall analyze and estimate future total and differential movements of all footings, slabs, pipelines, and engineered fills supporting structures. The settlement analysis calculations must be submitted. If professional judgment is used in addition to or to modify the calculated movement, justification or rationale used should be discussed. Where significant settlement is indicated, the geotechnical consultant should estimate the time for settlement to be 90% complete.

The geotechnical consultant shall indicate if a settlement-monitoring program is or is not recommended. If the consultant recommends a settlement-monitoring program, they should also recommend the location of surface monuments and/or subsurface settlement plates and a monitoring schedule.

#### **6.4.6 Stormwater**

##### **6.4.6.1 Identify Need for Stormwater Management Plan**

The Geotechnical consultant shall identify how stormwater will be managed, e.g. onsite infiltration facilities, connect to municipal stormwater drains, etc. If the proposed development will include onsite infiltration facilities, the Geotechnical Consultant's report shall include a description of the type(s) infiltration system to be used (e.g. dry well, settling pond, drain field, etc.<sup>10</sup>), and a description and site plan indicating the location(s) of the proposed infiltration system will be constructed.

##### **6.4.6.2 Site Characterization for Infiltration Facilities**

The detail and extent of the site characterization shall be appropriate for the proposed development and site specific conditions. Refer to Appendix G.,

#### **6.5 Recommendations**

##### **6.5.1 Grading**

Information regarding the City of San Diego's grading regulations can be found in the City of San Diego Municipal Code Chapter 12, Article 09, Division 06 and Chapter 14, Article 02, Division 01.

##### **6.5.1.1 Site Preparation**

Grading recommendations shall include comments on clearing and grubbing, removal of old fill, debris, and abandoned tanks, wells, and septic systems.

##### **6.5.1.2 Unsuitable Soil Removal**

Provide recommended limits and depth of removal of unsuitable soils. Indicate if the soil may be reused on site or if the unsuitable soil must be exported from the site.

##### **6.5.1.3 Transition Areas**

Recommend measures to mitigate potential differential soil movement across cut/fill transitions or a construction area with a significant differential fill thickness.

##### **6.5.1.4 Compaction Requirements**

Provide soil placement and compaction recommendations.

##### **6.5.1.5 Slopes**

Address the proposed slopes and provide recommendations for stable slope height and slope ratio (horizontal to vertical). Provide recommendations for toe and top of slope setback from property lines or existing structures and improvements. The need for slope terraces and terrace drains should be discussed.

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<sup>10</sup> Some infiltration facilities may be subject to federal, state, or local regulations.

The consultant must also provide recommendations for the construction of fill slopes and fill over cut slopes. Address keyways, benching, and surface and subsurface drainage. Typical details may be helpful to convey the consultant's recommendations.

#### **6.5.1.6 Slope Stabilization**

Describe all recommended stability fills or slope buttresses. For prescriptive stability fills, provide a typical detail illustrating the specifications of the grading and construction. Provide a map depicting the slope(s) recommended for stabilization. For non-uniform design, provide cross sections depicting the details of the recommended grading and construction. Address temporary slopes and subsurface drainage.

Detailed design recommendations must be provided for slope buttresses. The location of proposed buttresses must be depicted on a map (s) and cross section(s). Details of the construction (keyways, slot cuts, temporary slopes, etc) and subsurface drainage must be provided.

#### **6.5.1.7 Subdrains**

Preliminary geotechnical reports must include recommendations for subdrains. If subdrains are not recommended, this must be clearly stated.

Canyon subdrains shall consist of a minimum 6-inch diameter perforated pipe. The geotechnical consultant must provide recommendations for the type of pipe; drain material (gravel pack, filter fabric, etc); gradient; cut-off walls; outlet; and headwall design consistent with Greenbook standards. Graphical construction details of the canyon subdrain and headwall design must be provided. The recommended locations of canyon subdrains and outlets must be clearly shown on the grading plans.

When retaining walls are proposed, retaining wall subdrains (backdrain) recommendations must be provided in a preliminary geotechnical report. Retaining wall discharge points must be protected and clearly shown on grading plans and/or retaining wall plans.

Subdrain systems recommended for stabilization or buttresses fills must be clearly described and show on details, map(s), and cross-section(s).

Surface drainage systems must not connect to a subdrain. Subdrains must connect to a storm drain (preferably a catch basin) or outlet through a headwall. Connection of a subdrain to a pressurized storm drain is not permitted. Subdrains must not outlet onto a sidewalk or other area where seepage may cause a nuisance or hazard.

### **6.5.2 Foundations**

#### **6.5.2.1 Shallow Foundations (continuous and spread footings)**

A preliminary geotechnical report addressing shallow foundations is expected to address allowable bearing pressure, lateral pressures, coefficient of friction, minimum footing embedment, estimated total and differential settlement, and minimum slope setback.

#### **6.5.2.2 Deep Foundations (cast in hole caissons, driven piles, auger cast piles)**

Recommendations for the design of deep foundations are expected to address allowable vertical capacity (specify end bearing or skin friction) and lateral resistance from earth pressures. The geotechnical consultant should address recommended pile type, minimum pile embedment, pile diameter, pile spacing as well as construction recommendations.

Where applicable, the geotechnical consultant must address potential downdrag (negative friction) or reduction in lateral capacity or additional lateral demands due to ground or slope conditions under both static and earthquake induced loading.

#### **6.5.2.3 Slab on Grade**

All slab-on-grade construction, as a minimum, shall conform to CBC Chapters 18 and 19 and Appendix Chapter 18.

#### **6.5.2.4 Retaining Walls**

When retaining walls are proposed, the geotechnical consultant should provide recommendations for allowable bearing pressures, coefficient of friction against sliding, passive resistance, and lateral pressures. The lateral pressures must account for potential surcharge loads, hydrostatic pressure, expansive soil, adverse geology, slopes, etc.

Cantilever, freestanding retaining walls greater than 12 feet high should be designed to resist additional earth pressures caused by earthquake ground motion.

#### **6.5.2.5 Temporary Excavations and Shoring**

Recommendations for adequately stable temporary slopes must be provided. If temporary shoring is necessary, the geotechnical consultant must recommend the active and passive pressures, and lateral pressure distribution for design. If tieback anchors are necessary, the consultant must recommend the geometry of the active wedge to be used in the design.

Temporary slopes or shoring adjacent to existing improvements or the City's right of way, will require stability analysis and an explicit statement from the geotechnical consultant that the proposed temporary excavation or shoring system will be adequately stable. In addition, the geotechnical consultant must address potential soil movement associated with the excavation and the impact on existing improvements and utilities. The geotechnical consultant must provide recommendations for monitoring points and a monitoring schedule to evaluate soil movement adjacent to the temporary excavation.

The geotechnical consultant should review the structural calculations for temporary shoring systems to confirm that the geotechnical parameter used in the calculations are appropriate for the site conditions.

Temporary shoring system tieback anchors or soil nails within the upper 20-feet of the City's right of way must be removed and the removal confirmed by the geotechnical consultant. See Appendix E for the City's procedure regarding temporary shoring in the right of way.

### **6.5.3 Seismic Design Factors**

Seismic design factors must be provided in accordance with the CBC. All of San Diego is located in Seismic Zone 4. The Seismic Coefficients are based on the Soil Profile Type, which is based on specified physical parameters of the earth materials in the upper 100 feet of the site profile. When soil properties are not known in sufficient detail to determine the soil profile type, Type Sd shall be used. However, liquefiable soils, very high plasticity clays, peat, and other problems soils require site-specific evaluation. The default near source factor for the City of San Diego is Seismic Source 'B',  $\leq 2$  km.

If the dynamic analysis procedure of CBC is used, the consultant must provide the resulting response spectra for both horizontal and vertical ground motion, and the range of damping and period appropriate for the proposed structure. The consultant must provide a discussion of the procedures used including the computer program utilized; selection of attenuation function; fault model; and other user specified input parameters.

### **6.5.4 Drainage**

Preliminary geotechnical reports must address surface and subsurface drainage where necessary to mitigate differential movement due to expansive soils or hydroconsolidation, erodible soils, or surficial slope stability. Site surface drainage design and "Best Management Practices" (BMP's) including low impact development (LID) design is reviewed by the Engineering section at Development Services. Consultants should be familiar with the City's "Drainage Design Manual."

### **6.5.5 Infiltration**

Where stormwater infiltration facilities are included as part of the proposed site development, the Geotechnical Consultant shall provide recommendations for the design of stormwater infiltration facilities in accordance with Appendix G and good engineering practice. In addition, the Geotechnical consultant shall identify any potential impacts the planned stormwater infiltration facility may have on the development, property, or adjacent properties, including existing and future structures and/or improvements.

## **6.6. Illustrations**

### **6.6.1 Index Map (Site Location Map)**

Every preliminary geotechnical report must include an index map (location map). The location of the site should be clearly identified on a USGS 7.5 minute topographic base, City of San Diego topographic map, or a street map base. A street map base should only be used for relatively level sites adjacent to existing streets. The map should include a north arrow and scale.

### **6.6.2 Regional Geologic Map or Hazard Map**

Show the location of the site on regional geologic map or the San Diego Seismic Safety Study map. The map should include a north arrow and scale.

### **6.6.3 Geologic/Geotechnical Map**

A combined site-specific geological and geotechnical map or separate site-specific geological and geotechnical maps should accompany every preliminary geotechnical report. The maps should be on a topographic base that shows the proposed development. The map scale should be appropriate for the project and typically range from 1:120 to 1:2,400. All maps should include a legend of symbols, map scale, and north arrow.

Geologic maps are the product of independent observation of the licensed professional geotechnical consultant or qualified individuals under their supervision. These maps depict the distribution of geologic units and geologic structures within and adjacent to the project site. The geologic units should be divided into bedrock and surficial units. Contacts between units must be clearly delineated and observed versus interpreted contacts must be clearly defined. Geologic structures such as faults and folds must be indicated. Measured attitude of bedding, fractures, joints, faults, etc. based on surface geologic mapping and subsurface exploration must be indicated. The geologic map should depict significant features such as seeps or springs, scarps, cracks or fissures, creeping soil, marker beds, etc. The location of subsurface exploratory excavations, seismic survey lines, cross sections, etc. must be shown.

Geotechnical maps should show the locations of subsurface exploratory excavations and/or tests and cross sections. In addition, these maps must illustrate the location of recommended remedial measures. Examples include; buttresses, stabilization fills, canyon subdrains, buttress subdrains, retaining wall subdrains, settlement monuments, soil removal bottom elevations, over-size rock disposal zones, limits of remedial grading, building restricted use area, hazard zones, etc. For large projects, the consultant should consider numbering features such as proposed cut slopes, proposed buttresses, landslides, etc.

### **6.6.4 Geological/Geotechnical Cross Sections**

Cross sections are particularly useful for illustrating geologic conditions in relationship to proposed projects. The cross sections should depict existing and proposed grades and subsurface geologic and groundwater conditions. The location of exploratory excavations must be clearly depicted. Indicate the distance and direction that information is projected to a section. Clearly indicate true versus apparent dip of bedding or planar structures. Horizontal and vertical scale should be equal, but if an exaggerated section is necessary it must be clearly identified.

Geological cross sections should be positioned to take maximum advantage of available information or aligned to clarify the relationship of geologic structures and the proposed development. The geotechnical consultant should consider aligning sections to cross data points and minimize projecting information into the section. Intersecting cross sections can help constrain geologic interpretations and should be used to demonstrate the veracity of complex geologic models.

Geotechnical cross sections are typically presented for highest natural slope, cut slopes, and fill slope associated with a proposed project. Geotechnical cross sections should also be presented to show buttresses fills and keyways, shear keys, false slopes for soil removals, or other non-prescriptive geotechnical remedial design that can be depicted on a typical detail.

### **6.6.5 Typical Details**

Fully dimensioned typical details are important for conveying recommended design specifications. Typical details should be provided for the following: canyon subdrains, retaining wall subdrains and backfill, stabilization fills, fill over cut, transition building pad over-excavation, false slopes for removals, etc.

### **6.6.6 Photographs**

Photographs are optional, but can be useful in illustrating site conditions or specific features. Photographs can help reduce lengthy descriptions; however, each photograph must be described and the locations of photograph indicated.

## **7. AS-GRADED OR AS-BUILT GEOTECHNICAL REPORTS**

An as-graded or as-built geotechnical report is required to document geologic and geotechnical conditions encountered during construction and the construction was conducted in accordance with the geotechnical consultant's recommendations. In some cases, an interim as-graded or as-built geologic report will be required to confirm that geologic conditions encountered during grading were as anticipated. If, in the course of inspecting the construction, the geotechnical consultant encounters work not being done in conformance with the permitted plans, discrepancies must be reported immediately in writing to the owner, the contractor, and the City's permitting authority.

Outlined here are the major elements of an as-graded geotechnical report.

### **7.1 Introductory As-Graded Information**

#### **7.1.1 Project Description and Identification**

The report shall contain a description of the recently constructed project, project location, and identify the project permit and approved plans. For grading plans, the City's Work Order, Project Tracking System (PTS), and Drawing Number must be identified. For building plans, indicate the PTS number.

#### **7.1.2 Construction Summary**

Describe the construction that was performed. If the construction was conducted in phases, describe each phase. Provide a summary of the equipment used and start and end dates of construction. Identify the contractor and subcontractors involved in the construction that was observed by the geotechnical consultant.

#### **7.1.3 Scope of Services**

Provide a general description of the scope of geologic or geotechnical services that were provided.

### **7.2 As-Graded Conditions**

#### **7.2.1 Geologic Conditions**

Describe the geologic conditions encountered during the grading. Describe differences observed between the anticipated and observed conditions. Report any exploratory excavations conducted during construction to illuminate geotechnical conditions and provide logs of the excavations.

Provide a geologic or geotechnical map that illustrates the as-graded distribution of geologic units at the completion of the construction. The map should use the permitted plans as a base and must include a north arrow and scale. For sites with complex geology or complicated geotechnical remediation, separated as-graded geologic and geotechnical maps should be considered. On the map, show the exposed geologic conditions, including the distribution of geologic units, marker beds, and geologic structures. Indicate the attitude of bedding or other planar discontinuities such as faults, joints, and fractures. Depict the locations of springs or seeps on the as-graded geologic map. Removal bottoms and areas to receive fill should be field mapped by the geotechnical consultant.

Where changed geologic conditions are indicated, cross sections shown be presented that illustrate the as-graded conditions.

### **7.2.2 Geotechnical Conditions**

Soils encountered during grading should be characterized. Show the distribution of soils encountered during grading on the as-graded geotechnical map. For example, shown the distribution of alluvium, undocumented fill, and engineered fill. Identify the distribution of fill soil placed without adequate preparation of the subgrade.

Show the location and elevations of stabilization fill or buttress fill keyways on the geotechnical map. Depict the accurate and precise location of canyon subdrains, keyway subdrains, and other subsurface drainage. Indicate location of subdrain discharge points and, if not connected to a storm drain, the location of headwalls. Show the location of oversize rock windrows or disposal fields. Indicate the bottom elevation of over-excavations, removals, and cleanouts.

Indicate the location of any instrumentation such as settlement monuments, piezometers, inclinometers, extensometer, etc. on the geotechnical map.

### **7.3 Fill Placement and Compaction Testing**

Describe the areas of fill placed within the construction boundaries and the purpose for which the fill was placed. Discuss the preparation of subgrade to receive engineered fill. Characterize the material used as engineered fill within the construction area. Indicate maximum fill depth.

Discuss the field soil compaction operation and describe the procedure for testing fill soil compaction. Specifically address the operation used to compact soil near the face of fill slopes.

Provide a soil compaction test summary table that indicates test number, elevation, date, maximum dry density, optimum moisture, field dry density, field moisture content, and relative compaction.

Soil compaction test locations must be plotted on a map that shows the permitted construction, such as the grading plan or building plan. The map must be of sufficient scale to easily reviewed. The test numbers indicated on the map must correspond to the test numbers indicated in the soil compaction test summary.

If settlement monitoring was recommended, provide the results of the monitoring program.

### **7.4 Material Testing**

Report the soil expansion test results. For subdivision, the soil expansion index must be provided for each lot.

Report the results of soil corrosion tests, or other chemical tests as required.

### **7.5 Conclusions**

#### **7.5.1 Site Suitability**

The geotechnical consultant must provide a professional opinion as to the suitability of the site for the intended use.

#### **7.5.1 Changed Conditions**

If the observed geologic or geotechnical conditions differ from the anticipated conditions, the geotechnical consultant must clearly explain the differences. If there is a substantial change, the geotechnical consultant must present their re-evaluation. If the project involves cut slope or excavations, the consultant must provide a professional opinion that the excavations or slopes are adequately stable with respect to gross and surficial stability.

Any revised cross sections or stability analyses must be included in the as-graded geotechnical report to substantiate professional opinions.

The as-graded geotechnical report must reflect any and all approved construction changes.

#### **7.5.1 Opinion of Compliance**

The geotechnical consultant must provide an explicit statement addressing whether the soil engineering and engineering geologic aspects of the construction are in compliance with approved geotechnical report and geotechnical aspects of the construction. For grading plans, the consultant must specifically state that the soil engineering and engineering geologic aspects of the

grading are in compliance with the approved geotechnical report and geotechnical aspects of the grading plan (Drawing no. \_\_\_\_\_).

## **7.6 Recommendations**

### **7.6.1 Grading**

Address if there is any remaining grading to be conducted prior to completion of the construction. If necessary, provide recommendations for the remaining or corrective earthwork.

### **7.6.1 Foundations**

If necessary, provide updated recommendations for foundations, retaining walls, and improvements based on the encountered conditions and soil test results.

## **8. GEOTECHNICAL REPORTS FOR REPAIR (POST DISASTER)**

Numerous geotechnical hazards can cause damage and threaten the safety of structures. When repair or corrective work to protect existing structures such as buildings, roads, utilities, etc. is required, the design must meet all minimum standards contained in these guidelines for new construction as required in the City of San Diego Municipal Code. If a structure has been “Red Tagged” (deemed unsafe for occupancy) by the building official (or his/her representatives), it shall remain until the hazard is fully abated. Only a letter by the owner’s geotechnical consultant clearing the site of hazard, either by completed repairs or by finding the site stable and the structure safe to re-occupy shall the Red Tag be removed by the city. The consultant’s report must address the hazard and provide a professional opinion as to whether the site is now safe, or provide recommendations to make it safe.

In the event that the cost of the repair recommended by the geotechnical consultant may cause unreasonable hardship (i.e. exorbitant cost where the repair exceeds the value of the property), the owner may hire other geotechnical consultants for alternative recommendations or in rare instances the owner may sign and record a “Notice of Geologic and Geotechnical Conditions” which identifies the problem, the geotechnical report findings, and the owner’s acceptance of the less than ‘standard of care’ repair alternative. The notice is provided by the building official and includes complete release of liability for the city. In addition, it must be demonstrated to the satisfaction of the building official that the minimum standards cannot be met, the overall hazard will be reduced or lessened and that the endangered structures can continue to perform as intended, and that off-site property will not be adversely affected.

## APPENDIX A REFERENCES

- American Society of Civil Engineers, Los Angeles Section (2002), *Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Landslide Hazards in California*, T. F. Blake (Chair), R. Hollingsworth, and J. Stewart (Editors), Southern California Earthquake Center, February 2002 (Updated June 2002).
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- California Buildings Standards Commission (2002), 2001 California Building Code, Based on the 1997 UBC, Volumes 1 and 2 [Use Most Recent Version].
- California Department of Conservation (1997), *Guidelines for Evaluating and Mitigating Seismic Hazards in California*, Special Publication 117, Division of Mines and Geology.
- California Department of Conservation (1997), *Fault-Rupture Hazard Zones in California*, Special Publication 42, Division of Mines and Geology.
- California Department of Conservation (1986), *Guidelines to Geologic/Seismic Reports*, DMG Note 42, Division of Mines and Geology.
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- State Board of Registration for Geologists and Geophysicists (1998), *Guidelines For Engineering Geologic Reports*.
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### **Key Local Reference Documents**

- California Department of Conservation (2003), *State of California Earthquake Fault Zones, Point Loma 7.5-minute Quadrangle, San Diego County, California, Scale 1:24,000*, California Division of Mines and Geology.
- California Department of Conservation (1993), *State of California Earthquake Fault Zones, La Jolla 7.5-minute Quadrangle, San Diego County, California, Scale 1:24,000*, California Division of Mines and Geology.
- California Department of Conservation (1990), *Planning Scenario for a Major Earthquake, San Diego-Tijuana Metropolitan Area*, California Division of Mines and Geology, Special Publication 100.

- California Department of Conservation (2005), *Geologic Map of the San Diego 30' X 60' Quadrangle, California, Scale 1:100,000*, California Geological Survey.
- County of San Diego Watershed Protection, Stormwater Management and Discharge Ordinance (WPO) (2003) at County Code sections 67.801 *et seq.*
- Kennedy, M.P., Peterson, G.L., (1975), *Geology of the San Diego Metropolitan Area, California*, California Division of Mines and Geology, Bulletin 200.
- Kennedy, M.P. and Clarke, Samuel H. 1999, *Analysis of Late Quaternary Faulting in San Diego Bay and Hazards to the Coronado Bridge, San Diego, California*, California Division of Mines and Geology, OFR 97-10.
- Kennedy, M.P., and Tan, S.S., 1977, *Geology of National City, Imperial Beach, and Otay Mesa Quadrangles, Southern San Diego Metropolitan Area*: California Division of Mines and Geology Map Sheet 29.
- Kennedy, M.P., and Welday, E.E., 1980, *Recency and Character of Faulting, Offshore from Metropolitan San Diego, California; Point Loma to Baja California*: California Division of Mines and Geology Map Sheet 40, map 1:50,000.
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- Treiman, J.A., 1993, *The Rose Canyon Fault Zone, Southern California*: California Division of Mines and Geology, Open File Report 93-02, 45p.

## APPENDIX B FIELD EXPLORATION AND LOGS

Subsurface excavations for geologic and geotechnical exploratory are an integral part of an invasive investigations for direct observation, testing and sampling. Logs should be provided for all subsurface exploratory excavations that are part of an investigation. The types of logs are as varied as the types of exploratory excavations. Here are some common elements of all logs.

- Excavation ID
- Date or period of excavation and logging
- Project name
- Name of logger
- Method of exploration (e.g., hand excavated, bucket auger, rotary wash, etc)
- Total depth
- Groundwater observation
- Ground conditions, such as caving or flowing ground
- Shoring or casing
- Backfill material and backfill specification (i.e., concrete grout, compacted fill, etc.)

A legend should be provided that defines any symbols used on the log.

All logs should include a graphic depiction of the encountered conditions. Geologic conditions should be clearly depicted including contacts between units, bedding, fractures, joints, faults, etc. The geologic units should be described and classified. Geologic attitudes or other geologic data should be provided. Colors are often described, but without the use of a standardize color palate (e.g., Munsell Soil Color Charts or Rock Color Charts) they are at best imprecise. Typically soils for engineering purposes are described using the Unified Soil Classification System (USCS) or the Revised ASTM Standard on the Description and Identification of Soils (Visual-Manual Procedure). The soil classification system used should be clearly indicated on the log.

Type and depth range of samples should be clearly indicated on the log. Some sampling procedures must be described in detail to support the usefulness of the data. Some common sampling information may include:

- Type of sampler
- Field (unmodified) blow counts.
- Detail of Kelly bar weight and drop height.
- Hammer type (e.g., safety hammer).
- Method of hammer drop (e.g., automatic, cathead and rope with number of wraps)
- Percent recovery for rock cores.

*In situ* tests, such as pocket penetrometer, infiltration test, or vane shear results should be indicated on the log. Laboratory test data, such as dry density, moisture content, and degree of saturation are often presented on logs, and is recommended to facilitate correlation with other engineering properties.

Cone penetrometer test (CPT) data, should include profiles of cone tip resistance, either sleeve resistance or friction ratio, pore pressure, and, when available, shear wave velocity. Interpreted results, such as soil type and equivalent sample blow counts should be provided. The methodology for interpreting the CPT data should be cited. The type and size of cone and penetration rate shall be documented. CPT data is typically corroborated by at least one adjacent soil boring. Grouting or filling of the resulting CPT void should be described.

## **APPENDIX C MATERIALS TESTING**

Preliminary geotechnical reports should contain sufficient in-situ and/or laboratory test data to characterize the physical parameters of the earth materials affecting the proposed development and to substantiate calculations from which the conclusions and recommendations are derived. Sample preparation and testing procedures must be described in the report. Laboratory procedures are typically selected that will be representative of the site conditions during and after development of the site.

Test results should be presented in tabular form or as plots or illustrations of laboratory data. Numerical and graphical presentations of laboratory data that are commonly included in the report are:

- Dry density and moisture content of all samples.
- Soil classification (ASTM D422, ASTM 4318).
- Compaction curves plot showing maximum dry density and optimum moisture content for major soil types. (ASTM D1557)
- Grain-size analyses (sieve and hydrometer) for representative samples.
- Permeability (ASTM D2434-68)
- Consolidation tests plots for representative undisturbed samples and remolded samples to represent fill materials (ASTM D 2435). Show the impact of water inundation at proposed overburden pressures.
- Shear strength by direct shear, triaxial compression, and or unconfined compression tests (ASTM D3080, D2166, D2850). Provide plots and stress deformation curves. Indicate moisture content and degree of saturation of the tested sample. Residual shear strength under saturated conditions should be determined for use in slope stability analyses.
- Expansion index tests (UBC 29-2).
- Soil corrosivity testing including pH, chloride and sulfate contents, and resistivity.
- Tests to determine the R-value of potential subgrade materials when providing pavements sections.

## APPENDIX D TECHNICAL GUIDELINES FOR FAULT-RUPTURE HAZARD REPORTS

### A. GENERAL INFORMATION

1. Statement of Intent – These guidelines are intended to facilitate the investigation of surface fault-rupture hazard in the city of San Diego. The following outline provides a checklist for preparing well-documented reports. Not all checklist items will be applicable to every site or every project, but the investigative scope needs to be commensurate with the sensitivity of the intended use and the physical constraints of the site. No provision in these guidelines is mandatory or should be construed to constitute a statute, ordinance, or regulation, unless stipulated elsewhere.

These guidelines are for evaluating surface fault-rupture hazards in the city of San Diego. For other aspects of seismic hazard evaluation, refer to the *Guidelines for evaluating and mitigating seismic hazards in California*, 1997, California Geological Survey, SP 117. These guidelines supersede the City of San Diego, Technical Guidelines for Geotechnical Reports, Section V, Technical Guidelines for Seismic Reports, dated 1988.

2. Required Studies -Surface fault rupture investigations may be required for certain projects or subdivision maps in geologic hazard categories 11, 12, and 13 as delineated on the San Diego Seismic Safety Study maps, which are available at Development Services, City of San Diego. Refer to City of San Diego Municipal Code §145.0203 and City of San Diego Development Services' Information Bulletin 515 for the applications requiring a fault-rupture hazard investigation (available online).

Geologic Hazard Category 11 corresponds to the Earthquake Fault Zones delineated in compliance with the Alquist-Priolo Earthquake Fault Zoning Act (AP Act). The investigation of a site within hazard category 11 should be conducted per the requirements of the AP Act as well as City guidelines.

A fault rupture hazard investigation may be conducted as a stand-alone document or as part of a comprehensive geotechnical investigation.

3. Authentication –All fault hazard investigations conducted as part of the City of San Diego permit or approval process must be conducted by or under the supervision of a California Certified Engineering Geologist. All fault-rupture hazard reports submitted to the City of San Diego require signature and professional registration number of the project Certified Engineering Geologist.
4. Review – Fault hazard investigation reports submitted to the City may be evaluated for conformity with City and State standards. These guidelines are the basis for interpreting minimum City standards.

To facilitate reviews, consultants are encouraged to invite reviewers to observe field excavations for fault-rupture investigation. The reviewer(s) should be given sufficient advanced notification to allow for scheduling.

## B. FAULT RUPTURE HAZARD INVESTIGATION

### 1. Research

- a. Review published literature and maps regarding regional geology, faults, and other pertinent information.
- b. Search City records for fault investigation reports on properties in the site vicinity. Review pertinent reports on file for local geologic conditions, structural trends, ground water, and other pertinent factors.
- c. Analyze maps, aerial photographs, or other information to evaluate geomorphic features, soil or vegetation contrasts, or lineaments suggestive of faulting.
- d. Evaluate site-specific maps and plans to determine appropriate scope of field investigation.

### 2. Field Investigation

- a. **Surface mapping** – Natural or artificial exposures on or adjacent the site should be mapped in detail, particularly where used to demonstrate structural continuity or activity of faulting.

#### b. **Invasive subsurface exploration**

- i. *Trenching* - This is the preferred method of subsurface fault investigation as it allows direct and detailed observation of continuously exposed geologic units and structures. Trench depth must be sufficient to expose geologic features used to support conclusions. Trench walls must be properly prepared to allow accurate and detailed logging. Trenches are typically logged at a scale of 1:60. All geologic features should be logged and described in detail. Emphasis should be placed on defining and describing contacts between recognized units. Special attention should also be directed to evaluating and describing late Quaternary deformation of those units. Munsell color charts and notation should be used for describing color.
- ii. *Borings* – In-hole logged or continuously cored borings can provide an alternative to trenching at some sites where trenching is not feasible. The borings should be sufficient in number and adequately spaced to allow valid correlations and interpretations as well as provide optimal coverage. Boring depth must be sufficient to expose geologic features used to support conclusions. The boring should be logged in detail, similar to a fault trench. Standard, intermittently sampled, geotechnical borings are typically not adequate for fault investigations, but they may provide valuable supplemental information.
- iii. *Cone Penetrometer Testing (CPT)* – This technique may also provide an alternative to trenching at some sites where trenching is not feasible. The CPTs must be spaced on 10- to 15-foot centers and be sufficient in number to provide optimum coverage. Tighter spacing may be necessary to accurately locate faults. CPTs are typically advanced to a depth of ~50-feet or refusal. CPTs must be validated with a sufficient number of continuously logged borings. Discuss effect of deflection on results.
- iv. *Optimum Coverage* – Subsurface exploration should be located to intercept faults within 30-degrees of the expected trend.
- v. *Underground Service Alert (Dig Alert)* – Pursuant to State Assembly Bill (AB) 73, every person planning to conduct any subsurface excavation is required to contact a regional notification center at least 2 days prior to excavation and, if practical, delineate the areas to be excavated.

- vi. *County of San Diego Department of Environmental Health* – Contact the County regarding well/ boring permits and backfill requirements. Information is available on line.
  - vii. *City Right-of-Way* – The Trench-Cut Excavation Ordinance, O-19215, describes the requirements for excavations in the Public Right-of-Way. Consultants should also contact the City Engineer for permission to excavate in the Right-of-Way and for traffic control requirements.
  - viii. *Environmentally Sensitive Lands* – Prior to conducting subsurface exploration, grading for access, or other surface disturbance, determine if the proposed activity will impact environmentally sensitive lands. Consultants should contact the Environmental Analysis Section or Drainage and Grades Section of Development Services for requirements.
  - c. **Geophysical Methods** – High resolution seismic reflection, ground penetrating radar, residual gravity, electrical resistivity, and other geophysical surveys are indirect methods that may be used to target subsurface exploration or supplement subsurface exploration. Geophysical investigation should not be considered as an alternative to the invasive subsurface exploration methods described above.
3. Age-Dating Techniques – Chronologic control is crucial for determining the recency and activity of faulting. The most common techniques are:
- a. **Radiocarbon (<sup>14</sup>C) dating** – This isotopic method produces a numerical-age and has optimum resolution in the age range of interest for evaluating active faulting. This method depends on availability and preservation of carbon. It is subject to errors due to contamination. Laboratory documentation should be included in a report containing radiocarbon dates.
  - b. **Thermoluminescence (TL) and Optical Stimulated Luminescence (OSL) dating** – TL/OSL dating is an emerging approach for direct numerical dating of late Quaternary sediments based on radiogenic methods. Laboratory documentation should be included in a report containing TL or OSL dates.
  - c. **Soil-profile development** – Relative age determined from soil properties that systematically develop with time. The rate of soil development is dependent on other variables in addition to time and should be discussed. If soil-profile development is used for age dating, a detailed soil profile using standard procedures and terms should be provided (e.g., National Soil Survey Center Field Book for Describing and Sampling Soils).
  - d. **Stratigraphy** – Relative age determined from geologic sequences, age correlated to Quaternary climatic cycles. Depends on recognition of chronostratigraphic units. Basis for correlations and supporting data should be discussed in detail.
  - e. **Others** – Many other, less common, age-dating techniques are available that can be used to provide chronologic control. These other dating techniques, if used in the fault-rupture hazard evaluation, should be described in detail or key references provided.

## C. TYPICAL FAULT-RUPTURE HAZARD REPORT

- 1. Introduction
  - a. Purpose of investigation
  - b. Description of site location, size, and configuration; and existing site conditions
  - c. Description of proposed project

2. Scope of Investigation – Outline the methods and procedures used to evaluate fault-rupture hazards potentially impacting the proposed project or subdivision map.
3. Geologic Setting – Describe the major geomorphic and geologic features in the area of the site based on published or unpublished literature, maps, and records. The discussion should include:
  - a. Geomorphology/ physiographic features
  - b. Geologic or stratigraphic units and geochronology
  - c. Geologic structure
  - d. Other pertinent information (e.g., ground water)
4. Site Geology – Describe the geomorphology and geology of the site based on the results of the site-specific fault-rupture hazard investigation.
  - a. Stratigraphy and geochronology
    - i. Characterize pedogenic and/or stratigraphic units
    - ii. Describe contacts, unconformities, relationship of geologic units
    - iii. Discuss geochronology
  - b. Geologic structure
    - i. Attitude of bedding, fractures, joints, faults, etc.
    - ii. Describe fault features (e.g., gouge, breccia, slickensides, etc.)
    - iii. Describe folding or warping
  - c. Faulting and zones of deformation
    - i. Relative displacement/ fault movement
    - ii. Displacement history, timing of last event
    - iii. Slip rate
    - iv. Describe zones of deformation
5. Conclusions
  - a. An explicit professional opinion is necessary regarding the existence or absence of active faults or potentially active faults<sup>11</sup> on the site.
  - b. Probability of or relative potential for future surface displacement or deformation. The likelihood of future ground rupture or deformation can seldom be stated mathematically, but may be stated in semi-quantitative terms such as low, moderate, or high.
6. Recommendations
  - a. If hazardous faults have been identified on or adjacent to the site, recommend an appropriate structural setback zone.
  - b. Provide recommendations to mitigate potential impacts of tectonic ground deformation.
  - c. Need for additional studies.

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<sup>11</sup> A three-tier fault classification is used in the city of San Diego as follows: **Active Faults** – this class of fault has had demonstrable surface displacement during Holocene time; **Potentially Active Faults** - faults with Quaternary displacement, but no demonstrable Holocene surface displacement; **Inactive Faults** – pre-Quaternary faults. Faults that do not displace early Pleistocene units (e.g. Lindavista Formation) are considered inactive.

7. References – Cite all pertinent published and unpublished literature, reports, documents, maps, aerial photographs, or other information used in support of the investigation, conclusions, and professional opinions.
8. Illustrations – The following illustrations should be included in a typical fault-rupture hazard investigation report:
  - a. *Index map* – Identify the location of the site on a USGS 7.5 minute topographic map (1:24,000) or similar base map.
  - b. *Local fault map* – Illustrate the location of documented Quaternary faults within the vicinity of the site (1:2,400). Due to the rapidly evolving understanding of faulting in the downtown area, this map should be up-to-date.
  - c. *Geologic map* – Provide a geologic map on a site plan base. The map should depict the site boundaries, existing and proposed structures, geologic units, geologic structure, and location of exploratory excavations, geophysical traverses, and other pertinent information. Identified faults and any recommended setback zone should be clearly delineated on the plan. The plan should be 1:240 to 1:480 for most projects.
  - d. *Geologic cross sections* – Appropriately placed geologic cross sections should be provided to illustrate interpreted subsurface conditions and correlation of units. This is particularly necessary for illustrating the correlations between borings and CPT soundings.
  - e. *Graphic logs of exploratory excavations*
    - i. *Trench Logs* – Illustrate details of observed geologic features in a graphic log, which is typically depicted at a scale of 1:60 (vertical=horizontal scale). The logs should not be generalized or diagrammatic and should include vertical and horizontal scale control. The bearing of each linear trench or linear trench segment should be indicated. A legend of symbols and a detailed description of the recognized units should be presented on each log sheet. Benches, slopes, and shoring should be indicated, but should not obscure geologic details represented on the log. Emphasis should be placed on defining and describing contacts and intervening units.
    - ii. *Boring Logs* – A graphic log illustrating details of the observed geologic features should be provided for each boring log.
    - iii. *CPT Logs* – High quality color prints of the CPT logs should be included in reports where CPTs are used to support conclusions regarding faulting.
  - f. *Photographic Logs* – Trenches and core(s) used in fault investigations should be photographically documented. Photographs should be presented in the report, which are representative of the geologic features used to support conclusions.

## **APPENDIX E TEMPORARY SHORING IN THE CITY RIGHT OF WAY**

**APPENDIX F INFORMATION BULLETIN 560**  
**EXPLORATION IN ENVIRONMENTALLY SENSITIVE LANDS**

## **APPENDIX G EXAMPLE CHECKLIST FOR GEOTECHNICAL EVALUATION OF STORMWATER INFILTRATION FACILITIES**

Geotechnical investigations of stormwater infiltration facilities will vary based on the proposed facility and site specific conditions. The following checklist is presented for the information of the Developer and their Consultants as an example, or guide when developing a scope of a geotechnical evaluation of a stormwater infiltration facility. Project and site complexities may justify more extensive or detailed geotechnical investigations.

### **Pre-Investigation**

- ☐ Develop a scope of work to evaluate the geotechnical effects of the proposed stormwater infiltration system. The scope of work shall be approved by the Developer's Geotechnical Consultant who is a licensed Civil or Geotechnical Engineer in the State of California.
- ☐ Conduct reviews of available geologic, geologic hazard, groundwater, flood plan maps, and subsurface exploration logs.
- ☐ Identify:
  - ☐ Geologic history/geomorphology;
  - ☐ Geologic soil and rock units;
  - ☐ Geologic hazards;
  - ☐ Faults, folds and structures;
  - ☐ Regional groundwater conditions; and
  - ☐ Regional topography.
- ☐ Conduct reviews of available construction drawings of existing development at or near the site that could potentially be impacted by the infiltration facility.

### **Investigation**

- ☐ Conduct geotechnical site reconnaissance identifying:
  - ☐ Existing structures at or near the site;
  - ☐ Slopes in steeper than 5 horizontal to 1 vertical (5H:1V) in the vicinity of the site;
  - ☐ Existing utility trenches at or near the site;
  - ☐ Existing roadways, parking lots, and pavements at or near the site;
  - ☐ Wetlands and/or perennial and seasonal bodies of water at or near the site;
  - ☐ Topography in the vicinity of the Project;
  - ☐ Evidence of geologic hazards in the vicinity of the Project.
- ☐ Conduct geotechnical explorations within the footprint of the stormwater infiltration facility identifying:
  - ☐ Subsurface soil and rock conditions;
  - ☐ Any impermeable or low permeability soil or rock unit that would limit infiltration or cause lateral migration of stormwater;
  - ☐ Horizontal and vertical variations within the soil and rock units;

- ☐ Regional and perched groundwater conditions.
- ☐ Conduct geotechnical explorations that provide sufficient horizontal and vertical resolution of soil units within areas that will be affected by the proposed stormwater infiltration facility.
- ☐ Classify and log subsurface soil in accordance with Appendix B of the *City of San Diego Technical Guidelines for Geotechnical Reports*.
- ☐ Analyze soil using *in-situ* and/or laboratory testing to determine appropriate infiltration rates of each soil unit that will be influenced by the stormwater infiltration facility.
- ☐ Identify soils susceptible to piping, swell, hydroconsolidation, or other detrimental phenomena.

#### Analysis

- ☐ Develop a conceptual model of stormwater infiltration.
- ☐ Evaluate the effect of infiltration on property, features, and/or structures at or near the site.
- ☐ Develop an appropriate infiltration rate factor of safety to account for bio-accumulation/buildup, siltation, and the anticipated level of maintenance.
- ☐ Verify that the proposed infiltration facility conforms to the site Suitability Criteria established by the United States Environmental Protection Agency (EPA, 2004<sup>12</sup>), and/or those established by local regulatory agencies.

#### Construction Quality Control

- ☐ Verify that the Geotechnical Consultant has observed that construction methods, field conditions, and that the constructed stormwater infiltration facility conform to the parameters used in the design of the infiltration facility.
- ☐ Analyze and document that the infiltration system conforms to design specifications based on verification testing, if required by the City.
- ☐ Summarize field observations and verification testing in Daily Field Reports.

#### Reporting

- ☐ Submit a Geotechnical Report prepared by the Geotechnical Consultant summarizing all site conditions and recommendations. The Geotechnical Report shall be signed and stamped by the Geotechnical Consultant of Record who must hold a current license in Civil or Geotechnical Engineering in the State of California.
- ☐ Submit a Letter of Compliance prepared by the Geotechnical Consultant indicating whether or not the construction of the infiltration facility has been conducted in accordance with the Consultants design and recommendations. The Letter of Compliance shall include all daily field reports. The Letter of Compliance shall be signed and stamped by the Geotechnical Consultant of Record who must hold a current license in Civil or Geotechnical Engineering in the State of California.

**Additional Body Language removed from original Infiltration's version.....should be/could be included in this Appendix ??? .....use what is appropriate or add new copy**

#### **Stormwater**

##### **Identify Need for Stormwater Management Plan**

Geotechnical analysis shall identify how stormwater will be managed, e.g. onsite infiltration facilities, connect to municipal stormwater drains, etc. If the proposed development will include onsite infiltration facilities, the Geotechnical Consultant's report shall include a description of the type(s) infiltration system to be used (e.g. dry well, settling pond, drain field, etc.<sup>13</sup>), and a description and site plan indicating the location(s) of the proposed infiltration system will be constructed.

<sup>12</sup> Available at <http://www.epa.gov/nrmrl/pubs/600r04121/600r04121b.pdf>

<sup>13</sup> Some infiltration facilities may be subject to federal, state, or local regulations.

## **Site Characterization for Infiltration Facilities**

Geotechnical site characterizations for developments that will dispose of stormwater onsite shall include conditions at the site that are representative of stormwater infiltration conditions. The detail and extent of the site characterization shall be appropriate for the proposed development and site specific conditions. As a guideline, Geotechnical Reports for developments that include stormwater infiltration facilities shall, at a minimum, include the following information as it relates to such facilities:

### **Surface Conditions**

The Geotechnical Report should address relevant aspects of the surface conditions at the site including, but not limited to:

- Site location and address;
- Topography of the site and surrounding areas;
- Vegetation;
- Surface water (seasonal and perennial streams, ponds, standing water, springs, wetlands, etc.);
- Planned site use (commercial, residential, industrial or other specified use);
- Features of proposed development and nearby properties that may be effected by the proposed infiltration facility (structures, slopes, roadways, or other features); and
- Any other surface conditions deemed appropriate.

### **Geological Conditions**

The Geotechnical Report shall follow the appropriate recommended guidelines presented in sections 6.1, 6.2, and 6.3 of this document.

### **Subsurface Conditions**

Subsurface conditions shall be evaluated through a subsurface exploration program consisting of test pits and/or borings located within the footprint of the stormwater infiltration facility. Each exploration shall be advanced to a reasonable depth of influence below the proposed infiltration facility to identify soil units, soil conditions, and the presence of any impermeable strata. A sufficient number of explorations shall be conducted to evaluate horizontal variability of subsurface conditions. At the City's discretion, additional explorations may be required to characterized and evaluate subsurface conditions down-gradient of the proposed infiltration facility. The Geotechnical Consultant shall maintain a log of all explorations in accordance with the recommendations presented in Appendix B

Soil units encountered shall be tested to evaluate the infiltration properties of the soil using methods to be determined by the Geotechnical Consultant. All exploration and laboratory testing programs are subject to the approval of the City.

### **Groundwater**

Geotechnical Reports shall specifically address groundwater conditions at the location of the proposed infiltration facility, including, but not limited to:

- The elevation of the groundwater table;
- The elevation of any perched groundwater;
- Anticipated seasonal variations in groundwater elevations;
- Groundwater gradients and expected direction of flow;

- The presence of any impermeable strata that may impede stormwater infiltration; and
- Any additional groundwater concerns deemed appropriate by the consultant.

### **Stormwater Infiltration Conceptual Model**

The Geotechnical Consultant shall develop and describe a conceptual stormwater infiltration conceptual model based on infiltration volumes and surface, geologic, subsurface, and groundwater conditions. The complexity of the model shall be dependent on the proposed development and site conditions. At a minimum the model shall indicate infiltration flow paths, the ultimate destination of the infiltrated stormwater, and any conflicts between flow paths and adjacent features such as foundations, slopes, retaining walls, utility trenches, etc.

### **Evaluation of Potentially Impacted Features, Property and/or Facilities**

Where appropriate, the Geotechnical Report shall identify any property or facility that may be detrimentally impacted as result of stormwater infiltration or associated soil responses (e.g. reduction in soil strength, hydroconsolidation, soil swelling, piping, etc.). Potentially impacted Features and facilities may include, but are not limited to:

- Slopes;
- Foundations;
- Retaining walls;
- Utility trenches;
- Pavements;
- Roadways
- Basements; and
- Any additional feature or facility deemed appropriate by the consultant.

In addition, the Geotechnical Consultant's evaluation shall consider any detrimental effects of the infiltration facility on neighboring properties and how infiltration may affect future developments of such properties.

Consideration shall be given to any existing or planned features that may provide preferential drainage pathways, which may include, but are not limited to, utility trenches, drain tiles, man made fills, abandoned utility pipes, etc. Any such features shall be described in the Geotechnical Report and depicted on a site plan to show spatial relationships between the infiltration facility and the impacted feature. Geotechnical reports shall provide recommendations for decommissioning unused utilities and/or mitigating the detrimental effects of seepage along any preferential drainage pathway.

The Geotechnical Consultant shall provide recommendations for minimum offset distances between the infiltration facility and any potentially impacted features, property and/or facilities, or shall specify measures to eliminate the detrimental effects of the stormwater infiltration.

### **Infiltration Rate Determination**

The Geotechnical Consultant shall determine infiltration rates for each soil unit within a reasonable horizontal and vertical zone of influence of the infiltration facility. Infiltration rates shall be determined using methods accepted as standard engineering practice with respect to the site conditions and the proposed development. Infiltration rate shall include an appropriate factor of safety for site variability, bio-accumulation/buildup, siltation, and anticipated level of facility

maintenance. Typically, infiltration rates less than 0.52 inches per hour are deemed unacceptable for infiltration facilities (EPA, 2004).

**Verification**

Following the completion of construction, at the City's discretion, infiltration facilities may be subjected to verification testing. For Infiltration facilities that do not meet the required stormwater infiltration rates, the developer shall remediate, repair, or amend the stormwater facilities until the design stormwater infiltration rates are met.

**Authentication**

Geotechnical aspects of stormwater infiltration facility design, as described herein, shall be conducted by or under the direct supervision of a licensed Civil Engineer or Geotechnical Engineer who is registered with the State of California.